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Effect of Garlic, Moringa and Licorice Extracts on Vegetative Growth and Chemical Constituents of *Zanthoxylum beecheyanum* K. Koch Plant

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ABSTRACT

Two field experiments were conducted during (2017-2018) and (2018-2019) at a commercial Nursery (Abnaa Shaesha) of Dakahlia Governorate, Egypt to evaluate the effects of natural extracts of garlic, moringa, and licorice on enhancing vegetative growth and chemical constituents of Chinese pepper (*Zanthoxylum beecheyanum* K. Koch) plant. The concentrations of used natural extracts were 0, 5, 10 and 15 % of garlic and moringa extract and 0, 5, 10 and 15 g L^{-1} of licorice extract. These extracts were applied as a drench on the surface soil pots at 250 ml^{-1} pot from each extract twice monthly starting from May to September. Results indicated that treating Chinese pepper plants with garlic extract at 15 % recorded pronounced significant values in vegetative growth parameters such as number of branches, fresh and dry weight of leaves and branches as well as total alkaloids and phosphors % while, total chlorophyll, carotenoids, and total sugars were heights in response to garlic extract at 5 %. In addition, the superior plant contents from nitrogen and potassium % in the leaves were generally increased with the exogenous application of moringa extract at 5 %. Based on the obtained results, it could be concluded that applied of garlic extract at 15 % followed by 5 % gave the best vegetative growth and alkaloids percentage in *Zanthoxylum beecheyanum* plants under experiment condition.

Keywords: Chinese pepper, alkaloids, *Allium sativum*, *Glycyrrhiza glabra*, *Moringa oleifera*.

INTRODUCTION

Zanthoxylum beecheyanum K. Koch plant is one of 250 species approximately from Africa, Asia, America, and Australia, which belongs to family Rutaceae. Chinese pepper is a common name that shared with several *Zanthoxylum* species and suggests its medicinally and culinary use. It is around, dense, evergreen shrub up to 2 m tall with brownish bark with small spines up to 2.5-6.5 cm long. Its leaves are compound; each leaf has up to 15 green, glossy, entire, ovate 4-10 mm long leaflets with glands along the margins. The inflorescences are axillary fascicles of 1-2 mm yellow to green flowers, also, this plant considered a medicinal and aromatically plant since it contains many second metabolites (Weaver and Anderson, 2008). Medicinally, leaves have been used for treating bellyache and skin diseases as well as the effect in activating thermogenic sympathetic nerve and is effective for oral administration for inhibiting lipid accumulation (Yutaka *et al.*, 2004). Chinese pepper above-ground organs such as stem wood and stem bark as well as sub-ground such as root wood and root bark contain several bioactive compounds, including coumarins, furoquinoline alkaloids, lignans, steroids and terpenoids (Cheng *et al.*, 2004).

In the latest years, the world has become familiar with the environmental problem. So, researchers are working in the field of natural products that are available, safe, and low cost. The use of chemical fertilizers as plant nutrients sources is related to soil degradation and environmental pollution (Phiri, 2010).

Allium sativum L. (garlic) which belongs to family Alliaceae, its natural extract plays a positive function in some environmental stresses i.e. heavy metals on plant growth (Hanafy *et al.*, 1994). Allicin in garlic is a bioactive volatile compound containing Sulphur that has an antibacterial effect, antioxidant effects, antitumor promoting effects, and inhibits aflatoxin (Benkeblia and Lanzotti, 2007).

Moringa oleifera which belongs to family Moringaceae is being indicated to check its effect on growth and yield of crops and therefore can be confirmed between farmers as a potential complement or replacement to chemical fertilizers (Phiri, 2010). Fresh leaves of *Moringa oleifera* contain high zeatin levels in leaves (Fuglie, 2000). Zeatin is naturally cytokinin in plants that not only plays a role in cell elongation and cell division which promotes plant growth however also plays a role in protecting plants and delay of senescence. Thus, it is a perfect source of natural antioxidants (Anwar *et al.*, 2007).

Glycyrrhiza glabra (Licorice) which belong to family Fabaceae, its roots have some nutritional value and medical effect. The licorice extract includes an excess of 100 different compounds, some of which cumulated in great amounts, such as triterpenoid saponins which including glycyrrhizin and phenolic compounds (Shabani *et al.*, 2009). Also, licorice extract contains protein and amino acid asparagin, tannins, starch, lignins, monosaccharide, choline, various types of vitamins (C, E, B1, B2, B3, and B6), folic acid, mineral compounds (phosphorus, potassium, calcium, aluminum, magnesium, iron, zinc, cobalt and sodium) and bitter substance (Arystanova *et al.*, 2001).

So, applying the natural extracts for promoting the growth and productivity of many important plants. Hanafy *et al.* (2012) mentioned that treated *Schefflera arboricola*

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with garlic extract led to increasing leaves fresh and dry weight, total carbohydrates, and N contents followed by aloe extract and finally henna extract compared with the control. In addition, Saif Eldeen (2015) found that increasing exogenous application of moringa leaf extract and garlic extract rates up to 3 ml L^{-1} of each on artichoke (*Cynara scolymus* L.) led to a significant increase in vegetative growth characters (shoots number and leaves dry weight) compared with control. Besides, Taha *et al.* (2015) reported that the application of 10 % moringa leaves extract on jojoba plants caused an increase in chlorophyll a, b and carotenoids, but, 7 % of moringa leaves extract led to increment in the branches number, total phenolic, flavonoid, and tannins as compared to the control plants.

Moreover, Thanaa *et al.* (2016) revealed that foliar application of licorice extract at (10 g L^{-1}) was very effective in promoting characteristics of vegetative growth (branches number, shoots fresh and dry weight, leaves fresh and dry weight) and nutrient status (total chlorophyll) on almond seedlings. Over and above, Massoud *et al.* (2017) notice that the best values of fresh and dry weight and the chemical compounds of *Majorana hortensis* plant were increased when bio-gene plus phosphorene were joint with active garlic extract treatments. Likewise, Merwad (2018) reported that 4 % of moringa leaves extract significantly increased growth parameters, shoot dry weight, protein content, photosynthetic pigments, and nutrient accumulation of pea plants. Else, El-Rokiek *et al.* (2019) indicated that different concentrations of garlic extract at concentrations of 5, 10, and 15 % increased vegetative growth stages and photosynthetic pigments constituents (chlorophyll a, b and carotenoids) of quinoa leaves.

So, the aim of this study was to find a way for improving the vegetative growth and chemical constituents of *Zanthoxylum beecheyanum* plant by using natural extracts. This is because of its pharmaceutical and aesthetic importance, as a trial for minimizing the use of synthetics chemical fertilizers.

MATERIALS AND METHODS

This experiment was conducted at a commercial Nursery (Abnaa Shaesha) of Dakahlia Governorate, Egypt during the two seasons, (2017-2018) and (2018-2019), in a trial for improving the vegetative growth and chemical constituents of *Zanthoxylum beecheyanum* K. Koch plant by using some natural extracts (garlic, morimga, and licorice) under the local environment of Egypt as a synthetics material because of the importance of this plant as a pharmaceutical and aesthetic

1. Plant Material:

Approximately of nine months' uniform *Zanthoxylum beecheyanum* obtained from a commercial Farm in Al-Qanater El-khyriyyah, El-Qlyubia Governorate, Egypt. Then planted it in 25 cm plastic pots in the experiment beginning (1st May) and transplanted in 40 cm pot after 12 months (25th April) filled with mixture clayed soil with organic manure in the both seasons of the experiment. The physical and chemical properties of soil experiment medium in the two seasons were shown in Table (1). All pots were fertilized with 10 g pot^{-1} NPK (20:20:20) every two months.

Table 1. The physical and chemical properties of experiment soil.

Physical properties								Chemical properties		
Sand %	**Silt %**	**Clay %**	**Texture class**			**pH**		**Ec ds m^{-1}**		**OM %**
20 .4	30.9	48.7	Clayey			7.9		0.38		1.05
Soluble cations (meq/100g)				Soluble anions (meq/100g)				Available macro-nutrients mg/kg		
Ca^{++}	Mg^{++}	K^{+}	Na^{+}	Co^{-2}	Hco_3^{-}	Cl^{-}	So_4^{-2}	N	P	K
0.76	0.57	0.19	2.28	-	0.45	3.04	0.31	53.28	6.40	214.16

2. Preparation of natural extracts

Preparation of garlic extract

Different garlic aqueous extracts (5, 10, and 15 %) were prepared by blending 50, 100 and 150 g L^{-1}, respectively of fresh mature garlic cloves in tap water, then all aqueous extracts were frozen and thawed two times. Then all extracts were filtered and diluted by tap water to reach one liter (El-Desouky *et al.*, 1998). The quantitative phytochemical result, proximate composition and minerals composition of the aqueous garlic extract analysis is shown in (Table 2) by (Ali and Ibrahim 2019).

Table 2. The quantitative phytochemical, minerals composition and proximate composition of the aqueous garlic extracts

Phytochemical Quantitative Analysis(%)		Nutrient Composition (%)		Minerals Composition (mg $100g^{-1}$)	
Alkaloids	7.20	Carbohydrate	66	Calcium	23.4
Tannin	4.80	Protein	16.23	Potassium	10.95
Saponin	4.30	Ash content	5.85	Phosphorous	9.85
Flavonoid	2.18	Moisture content	5.52	Iron	5.2
Anthraquinones	1.40	Crude fiber	3.96	Magnesium	3.9
Phenols	0.80	Fats	2.44	Zinc	0.44
Steroids	0.50			Copper	0.05
Terpenoid	0.40				
Glycosides	0.05				

Preparation of moringa extract

Moringa extract (5, 10, and 15 %) were prepared by blending 50, 100 and 150 g L^{-1} of young moringa fresh leaves in tap water until obtained homogenized suspended, then it filtered and diluted by tap water to reach one liter (Nouman *et al.*, 2012). The quantitative phytochemical result, proximate composition and minerals composition of the aqueous leaf extracts of *Moringa oleifera* analysis were shown in (Table 3) by (Nweze and Nwafor 2014).

Table 3. The quantitative phytochemical, minerals composition and proximate composition of the aqueous leaf extracts of *Moringa oleifera*.

Phytochemical Aqueous extract (g $100g^{-1}$)		Nutrient Composition (g $100g^{-1}$)		Minerals Composition (g $100g^{-1}$)	
Anthraquinone	11.68	Carbohydrate	57.01	Nitrogen	3.03
Tannins	9.36	Protein	18.92	Calcium	2.09
Terpenoids	4.84	Fibre	9.31	Potassium	1.62
Flavonoid	3.56	Ash	7.95	Sulphur	0.85
Steroids	3.21	Moisture	4.09	Magnesium	0.48
Alkaloids	3.07	Fats	2.74	Phosphorous	0.44
Saponins	1.46			Iron	0.03
Carotenoids	1.16			Copper	0.01
Cardiac glycoside	0.36			Zinc	0.005
Anthocyanin	0.06				

Preparation of licorice extract

Licorice roots aqueous extract of 5, 10, and 15 g L^{-1} were prepared by soaking in a half-liter of tap water for 24 hours then it filtered. The extracts residual was boiled in another half-liter of tap water for 15 minutes then it filtered after cooling. Finally, the first filter extracts were mixed with the second filter extracts and completed by tap water to one liter. The quantitative phytochemical result, proximate composition and minerals composition of the aqueous licorice extract analysis is shown in (Table 4) by (Morsi *et al.,* 2008).

Table 4. The quantitative phytochemical and minerals composition of the aqueous licorice extracts

Phytochemical extract(mg 100g^{-1} DW)	Aqueous	Mineral Composition (mg 100g^{-1} DW)	
Total phenol	405.0	Potassium	341.5
Total flavonoids	114.9	Magnesium	174.7
Tannins	47.54	Sodium	122.8
Saponins	27.99	Calcium	104.55
Carotenoids	11.78	Zinc	0.40
Vitamin C	1.20	manganese	0.40
		Iron	1.19
		Copper	0.18

The analysis of tap water which used for preparing the previous extracts is shown in (Table 5) by (El-Harouny *et al.,* 2008).

Table 5. Mean concentrations of heavy metals and trace elements in the studied drinking tap water using in natural extracts preparation.

Ca (mg L^{-1})	Mg (mg L^{-1})	Na (mg L^{-1})	Zn (µg L^{-1})	Se (µg L^{-1})	Cd (µg L^{-1})	Pb (µg L^{-1})	As (µg L^{-1})	Hg (µg L^{-1})
10.9	10	8.1	9	1.6	0.7	0.3	0.1	0.04

3.Experimental design and treatments:

The layout of this experiment was a simple experiment in a randomized complete block design contains 10 treatments with three replicates each of which contained three pots for each treatment. All extracts were applied as a drench on the surface soil pots at 250 ml pot^{-1} from each extract twice monthly during the first of May to the end of September and the experiment continued for 17 months in two seasons. The treatments were classified as follows:

1. Control (Tap water)
2. Garlic extracts (G.E. 5, 10, and 15 %)
3. Moringa extract (M.E. 5, 10, and 15 %)
4. Licorice extract (L.E. 5, 10, and 15 g L^{-1})

Data Recorded

Vegetative growth

1. Change of branches number after 3, 5, 15, and 17 months from the beginning of the experiment. It was calculated according to the following formula (change of branches number = $N_n - N_0$) where N_n: branches number after 3, 5, 15 and 17 months; N_0: number of branches at the beginning of the experiment.
2. Fresh and dry weights of branches g $plant^{-1}$ after 5 and 17 months from the beginning of the experiment.
3. Fresh and dry weights of leaves g $plant^{-1}$ after 5 and 17 months from the beginning of the experiment.

Chemical analysis

These determinations were after 5 and 17 months from the beginning of the experiment.

1. Total chlorophyll and carotenoids were determined according to Costache *et al.* (2012)
2. Total sugars of air-dried leaves were determined according to Dubois *et al.* (1956)
3. Total alkaloids were determined according to Harborne (1973)
4. Nitrogen percentage was determined by modified Micro Kjeldahl method as described by Pregl (1945).
5. Phosphorus percentage was determined according to Rao *et al.,* (1997)
6. Potassium percentage was determined according to Black (1965).

Statistical Analysis:

Data were undergone to the analysis of variance (ANOVA) using the Costat v. 6.303 (1986) program. Means were compared by the least significance difference (LSD) test at the 0.05 prospect level according to the procedure as mentioned by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Results

This investigation aimed to find out the best natural extract form some different sources of the plant e.g. (garlic and moringa leave extracts at 5, 10 and 15 %, and Licorice roots extract at 5, 10 and 15 g L^{-1}) on some vegetative growth parameters and chemical constituent of *Zanthoxylum beecheyanum* plant.

Vegetative growth parameters:

Change of branches number

Data presented in Table (6) showed that no significant differences between all-natural extracts treatments on change of branches number of *Zanthoxylum beecheyanum* plants after 3 months in both seasons. While, recorded 15 % garlic extract the highest value for change of branches number in all periods without significant difference between 15 % garlic extract and 5 % moringa extract as (30.6, 31.0) and (32.4, 32.6), respectively at the end of the experiment after 17 months in both seasons, except for addition 5 % moringa extract recorded the highest value after 15 months as (24.8 and 24.4) in the two seasons, respectively.

Fresh and dry weights of branches

Data presented in Table (7) revealed that the branches fresh and dry weight of *Zanthoxylum beecheyanum* plants was significantly affected by all-natural extracts treatments. The highest fresh and dry weights of branches were obtained from 15 % garlic extract treatment after 5 and 17 months during the two seasons which recorded (52.9, 49.6 g $plant^{-1}$ and 20.8, 21.8 g $plant^{-1}$) and (1559.9 and 1164.5 g $plant^{-1}$) and (762.3 and 565.8 g $plant^{-1}$) for fresh and dry weight, respectively. The increasing percentage of fresh weight of branches at the end of the experiment was 68.62 and 53.73 % in both seasons, respectively as compared to the control.

Table 6. Effect of exogenous applications with garlic, moringa, and licorice extracts on change of branches number of *Zanthoxylum beecheyanum* plant after 3, 5, 15, and 17 months from the first of the experiment during 2017-2018 and 2018-2019 seasons.

Treatments	Change of branches number							
	1st season				2nd season			
	3 months	5 months	15 months	17 months	3 months	5 months	15 months	17 months
Control	4.8 a	12.2 a	20.0 ab	24.0 ab	5.0 a	12.0 a	20.2 ab	24.4 ab
G.E. 5 %	6.4 a	12.0 ab	21.2 ab	27.8 ab	6.2 a	11.8 a	21.6 ab	27.6 ab
G.E. 10 %	5.6 a	10.8 abc	20.6 ab	25.2 ab	5.8 a	11.0 a	20.8 ab	24.6 ab
G.E. 15 %	5.6 a	13.4 a	17.2 abc	30.6 a	5.4 a	13.2 a	17.6 abc	31.0 a
M.E. 5 %	5.2 a	11.8 ab	24.8 a	32.4 a	4.8 a	11.4 a	24.4 a	32.6 a
M.E. 10 %	5.2 a	11.6 ab	19.4 abc	26.6 ab	5.4 a	11.4 a	19.2 ab	27.0 ab
M.E. 15 %	4.0 a	10.8 abc	19.6 abc	31.4 a	3.8 a	10.6 a	19.2 ab	31.0 a
L.E. 5 g L^{-1}	5.6 a	8.6 bc	14.8 bc	21.2 b	5.8 a	8.4 a	15.2 bc	22.0 b
L.E.10 g L^{-1}	4.8 a	8.0 c	11.2 c	21.2 b	4.6 a	7.8 a	11.4 c	21.6 b
L.E.15 g L^{-1}	5.6 a	10.0 abc	14.8 bc	20.4 b	5.8 a	9.8 a	14.6 bc	22.0 b
L.S.D 5 %	NS	3.5	8.5	9.0	NS	NS	7.6	8.9

Means within columns followed by different letters are significantly different ($p<0.05$), G.E., garlic extract; M.E., moringa extract; L.E., licorice extract; NS, non-significant.

Table 7. Effect of exogenous applications with garlic, moringa, and licorice extracts on the fresh and dry weight of branches (g $plant^{-1}$) of *Zanthoxylum beecheyanum* plant after 5 and 17 months from the first of the experiment during 2017-2018 and 2018-2019 seasons.

Treatments	Fresh and dry weight of branches g $plant^{-1}$							
	1st season				2nd season			
	5 months		17 months		5 months		17 months	
	FW	DW	FW	DW	FW	DW	FW	DW
Control	44.9 bc	19.0 ab	925.1 bc	461.6 bc	44.9 ab	20.0 a	757.5 c	361.1 b
G.E. 5 %	49.7 ab	20.4 a	1046.0 bc	546.5 ab	43.7 b	20.1 a	820.5 c	422.5 ab
G.E. 10 %	44.8 bc	18.4 ab	915.0 bc	446.2 bc	44.3 ab	17.8 b	888.8 bc	465.5 ab
G.E. 15 %	52.9 a	20.8 a	1559.9 a	762.3 a	49.6 a	21.8 a	1164.5 a	565.8 a
M.E. 5 %	41.4 cd	16.3 bc	1068.7 ab	527.9 bc	40.3 bc	15.8 cd	917.1 abc	461.2 ab
M.E. 10 %	35.0 e	13.4 de	1041.6 bc	520.4 bc	39.5 bc	15.3 cd	1144.0 ab	553.6 a
M.E. 15 %	35.2 e	13.9 cd	1255.9 ab	610.5 ab	36.1 c	13.9 d	1150.6 a	561.9 a
L.E. 5 g L^{-1}	27.4 f	10.5 e	930.6 bc	450.1 bc	28.1 d	10.5 e	979.3 abc	498.8 ab
L.E.10 g L^{-1}	29.1 f	10.8 e	854.7 bc	396.6 bc	27.8 d	10.9 e	926.9 abc	445.0 ab
L.E.15 g L^{-1}	39.9 de	16.2 bcd	658.8 c	306.8 c	36.8 c	16.6 bc	804.5 c	380.4 b
L.S.D 5 %	5.4	2.9	456.4	232.4	5.8	2.0	260.1	147.2

Means within columns followed by different letters are significantly different ($p<0.05$), G.E., garlic extract; M.E., moringa extract; L.E., licorice extract; FW, fresh weight; DW, dry weight.

Fresh and dry weights of leaves

Data in Table (8) presented more significant increments of leaves weight during both seasons. The treatment of 15 % garlic extract gave the heaviest fresh and dry leaves weight (335.6 and 367.5 g $plant^{-1}$) and (92.1 and 97.9 g $plant^{-1}$), (3103.1 and 4997.6 g $plant^{-1}$) and (941.4 and 1462.9 g $plant^{-1}$), after 5 and 17 months for both seasons, respectively. The increasing percentage of leaves fresh weight at the end of the experiment was 33.13 and 111.60 % in both seasons, respectively as compared to the control.

Table 8. Effect of exogenous applications with garlic, moringa, and licorice extracts on the fresh and dry weight of leaves (g $plant^{-1}$) of *Zanthoxylum beecheyanum* plant after 5 and 17 months from the first of the experiment during 2017-2018 and 2018-2019 seasons.

Treatments	Fresh and dry weights of leaves g $plant^{-1}$							
	1st season				2nd season			
	5 months		17 months		5 months		17 months	
	FW	DW	FW	DW	FW	DW	FW	DW
Control	297.3 b	82.7 bc	2330.9 ab	763.9 ab	297.7 bc	81.1 bc	2361.8 bc	696.8 bc
G.E. 5 %	298.6 b	85.0 ab	3027.3 a	885.7 a	321.5 b	88.3 ab	2434.4 bc	721.2 bc
G.E. 10 %	278.8 b	79.2 bcd	2674.0 ab	781.6 ab	280.9 cd	77.4 bc	2637.6 bc	813.4 bc
G.E. 15 %	335.6 a	92.1 a	3103.1 a	941.4 a	367.5 a	97.9 a	4997.6 a	1462.9 a
M.E. 5 %	282.9 b	76.0 cd	3088.6 a	940.6 a	260.5 cde	70.6 cd	2855.8 b	827.2 bc
M.E. 10 %	245.2 c	62.9 e	2982.5 a	893.8 a	237.8 e	62.8 d	2931.1 b	886.2 b
M.E. 15 %	283.6 b	72.0 d	3082.1 a	923.5 a	251.6 de	60.9 de	3010.4 b	871.6 b
L.E. 5 g L^{-1}	202.3 d	53.9 f	2701.3 ab	809.3 ab	189.9 f	49.6 de	2724.7 bc	810.6 bc
L.E. 10 g L^{-1}	202.1 d	51.2 f	2567.7 ab	730.2 ab	172.7 f	45.6 f	2226.1 bc	649.0 bc
L.E. 15 g L^{-1}	281.0 b	74.5 cd	2020.5 b	587.8 b	286.7 bcd	76.0 c	1916.9 c	561.4 c
L.S.D 5 %	27.6	8.6	827.9	268.1	40.6	11.4	918.4	296.2

Means within columns followed by different letters are significantly different ($p<0.05$), G.E., garlic extract; M.E., moringa extract; L.E., licorice extract; FW, fresh weight; DW, dry weight.

Chemical constituents:

Chlorophyll concentration

Results presented in Table (9) showed that all the applied treatments of natural extracts at all rates had a significant effect on total chlorophyll (mg g^{-1} FW) of *Zanthoxylum beecheyanum* plant. The highest values resulted from 5 % garlic extract, which recorded 0.98 and 0.85 mg g^{-1} FW after 5 months respectively, in both seasons

and 1.24 and 1.23 mg g-1 FW after 17 months respectively in both seasons compared with most of the other treatments.

Carotenoids concentration

It is evident from the results in Table (9) that all treatments of natural extracts at all rates had a significant effect on carotenoids concentration in *Zanthoxylum beecheyanum* plants comparing with the control. The highest carotenoid content resulted from the treatment of 10 % garlic extract, after 5 months and 5 % garlic extract after 17 months in the two seasons, respectively. The increasing % in carotenoids concentration after 5 months reached to 81.08 and 69.23% comparing with the control in the two seasons, respectively.

Table 9. Effect of exogenous applications with garlic, moringa, and licorice extracts on photosynthetic pigments (mg g^{-1} FW) in the leaves of *Zanthoxylum beecheyanum* plants after 5 and 17 months from the first of the experiment during 2017-2018 and 2018-2019 seasons.

Treatments	Total chlorophyll		Carotenoids	
	1st season			
	5 months	17 months	5 months	17 months
Control	0.28 f	1.04 ab	0.074 d	0.102 abc
G.E. 5 %	0.98 a	1.24 a	0.124 ab	0.126 a
G.E. 10 %	0.82 abc	0.91 ab	0.134 a	0.085 abc
G.E. 15 %	0.64 bcde	0.78 ab	0.072 d	0.055 bc
M.E. 5 %	0.60 cde	0.69 b	0.102 abcd	0.047 c
M.E. 10 %	0.78 abcd	0.66 b	0.106 abcd	0.054 bc
M.E. 15 %	0.87 ab	0.74 ab	0.109 abc	0.118 ab
L.E. 5 g L^{-1}	0.55 de	1.10 ab	0.085 cd	0.073 abc
L.E.10 g L^{-1}	0.66 bcde	1.04 ab	0.091 bcd	0.083 abc
L.E.15 g L^{-1}	0.47 ef	0.60 b	0.081 cd	0.051 bc
L.S.D 5 %	0.24	0.55	0.035	0.069
Treatments	2nd season			
	5 months	17 months	5 months	17 months
Control	0.38 e	1.05 ab	0.078 d	0.103 ab
G.E. 5 %	0.85 a	1.23 a	0.106 b	0.122 a
G.E. 10 %	0.67 bc	0.81 abc	0.132 a	0.075 ab
G.E. 15 %	0.62 cd	0.72 bc	0.123 ab	0.071 ab
M.E. 5 %	0.56 d	0.68 bc	0.081 cd	0.056 b
M.E. 10 %	0.76 ab	0.61 c	0.101 bcd	0.070 ab
M.E. 15 %	0.71 ab	0.65 bc	0.115 ab	0.073 ab
L.E. 5 g L^{-1}	0.58 cd	1.11 ab	0.078 d	0.083 ab
L.E.10 g L^{-1}	0.62 cd	1.02 abc	0.098 bcd	0.060 b
L.E.15 g L^{-1}	0.57 cd	0.77 abc	0.105 bc	0.055 b
L.S.D 5 %	0.15	0.47	0.025	0.052

Means within columns followed by different letters are significantly different (p< 0.05), G.E., garlic extract; M.E., moringa extract; L.E., licorice extract.

Total alkaloids percentage

It is obvious from data in Table (10) that the natural extracts treatments achieved a significant effect on total alkaloids percentage in branches of *Zanthoxylum beecheyanum* plants comparing with the control treatment. The highest values of total alkaloids percentages in branches resulted from applying 5 % moringa leaf extract 5 months and 15 % moringa leaf extract after 17 months in the two seasons. The superior of total alkaloids % reached to 135.56 % and 133.71 % after 5 months and 197.83 and 202.22 % after 17 months in the two seasons, respectively.

Total sugars concentration

As regarding data in Table (10), there was a significant effect of 10g L^{-1} licorice extract on the total sugars content after 5 months (0.283 and 0.304 mg g^{-1} DW) during both seasons, respectively. While, after 17 months' plants treated with 5 % garlic extract had the highest total sugars content (0.070 and 0.059 mg g^{-1} DW), respectively in both seasons compared with other treatments.

Table 10. Effect of exogenous applications with garlic, moringa, and licorice extracts on total alkaloids percentage and total sugars concentration (mg g^{-1} DW) of *Zanthoxylum beecheyanum* plants after 5 and 17 months from the first of the experiment during 2017-2018 and 2018-2019 seasons.

Treatments	Total alkaloids		Total sugars	
	1st season			
	5 months	17 months	5 months	17 months
Control	0.90 bcd	0.46 c	0.073 e	0.059 abc
G.E. 5 %	0.75 cd	0.65 bc	0.022 f	0.070 a
G.E. 10 %	0.74 cd	0.81 abc	0.025 f	0.051 c
G.E. 15 %	1.57 abc	1.18 ab	0.021 f	0.062 abc
M.E. 5 %	2.12 a	0.60 c	0.106 d	0.055 bc
M.E. 10 %	0.70 d	0.74 bc	0.119 d	0.070 a
M.E. 15 %	1.70 ab	1.37 a	0.193 c	0.060 abc
L.E.5 g L^{-1}	1.14 bcd	0.45 c	0.240 b	0.056 bc
L.E.10g L^{-1}	1.09 bcd	0.63 bc	0.283 a	0.063 ab
L.E.15g L^{-1}	0.87 bcd	0.45 c	0.023 f	0.066 ab
L.S.D 5 %	0.87	0.58	0.026	0.012
Treatments	2nd season			
	5 months	17 months	5 months	17 months
Control	0.89 bc	0.45 c	0.062 e	0.044 ab
G.E. 5 %	0.74 bc	0.64 bc	0.019 f	0.059 a
G.E. 10 %	0.74 bc	0.79 bc	0.028 f	0.037 b
G.E. 15 %	1.50 ab	1.19 ab	0.028 f	0.055 a
M.E. 5 %	2.08 a	0.60 c	0.113 d	0.047 ab
M.E. 10 %	0.69 c	0.78 bc	0.104 d	0.050 ab
M.E. 15 %	0.95 bc	1.36 a	0.195 c	0.051 ab
L.E.5 g L^{-1}	1.13 bc	0.45 c	0.252 b	0.037 b
L.E.10g L^{-1}	1.09 bc	0.63 bc	0.304 a	0.057 a
L.E.15g L^{-1}	0.86 bc	0.45 c	0.020 f	0.056 a
L.S.D 5 %	0.78	0.56	0.031	0.015

Means within columns followed by different letters are significantly different (p< 0.05), G.E., garlic extract; M.E., moringa extract; L.E., licorice extract.

Nitrogen, phosphors and potassium percentage

It is clear from data in Table (11) that natural extract treatments affected on the nitrogen, phosphorus, and potassium percentages in leaves of *Zanthoxylum beecheyanum* plants. The highest nitrogen (2.33 and 2.34 N %) obtained from 10 g L^{-1} licorice extract while the superior phosphors (0.123 and 0.122 P %) and potassium (2.165 and 2.143 K %) came from applying 15 % moringa leaf extract after 5 months in both seasons, respectively. On the other hand, after 17 months the highest values of nitrogen and potassium were (2.535 and 2.533 N %) and (2.200 and 2.167 K %) resulted from using 5 % moringa leaf extract while, the highest values of phosphors were (0.116 and 0.117 P %) resulted from using 15 % garlic extract in both seasons, respectively compared with other treatments.

Table 11. Effect of exogenous applications with garlic, moringa, and licorice extracts on nitrogen, phosphors and potassium percentage of *Zanthoxylum beecheyanum* plants after 5 and 17 months from the first of the experiment during 2017-2018 and 2018-2019 seasons.

Treatments	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
	1st season					
	5 months			17 months		
Control	2.200 bc	0.083 f	1.920 cde	2.230 ef	0.090 d	2.025 bc
G.E. 5 %	2.175 c	0.084 f	2.050 b	2.230 ef	0.089 d	2.025 bc
G.E. 10 %	2.190 c	0.091 d	1.980 bc	2.145 f	0.088 d	2.020 bc
G.E. 15 %	2.235 bc	0.097 c	1.860 e	2.445 ab	0.116 a	1.995 bc
M.E. 5 %	2.200 bc	0.075 g	1.820 ef	2.535 a	0.095 c	2.200 a
M.E. 10 %	2.265 ab	0.097 c	1.975 bcd	2.350 bcd	0.108 b	2.125 ab
M.E. 15 %	2.205 bc	0.123 a	2.165 a	2.375 bc	0.107 b	2.000 bc
L.E.5 g L^{-1}	2.225 bc	0.090 d	1.720 f	2.325 cde	0.089 d	2.060 abc
L.E.10gL^{-1}	2.330 a	0.110 b	1.870 de	2.260 de	0.106 b	1.935 c
L.E.15gL^{-1}	2.195 c	0.086 e	2.075 ab	2.255 de	0.097 c	1.900 c
L.S.D 5 %	0.066	0.001	0.108	0.108	0.003	0.167
Treatments	2nd season					
	5 months			17 months		
Control	2.197 cd	0.082 g	1.910 cd	2.220 fg	0.092 d	2.050 abc
G.E. 5 %	2.180 d	0.083 g	2.083 ab	2.227 efg	0.091 de	2.033 abc
G.E. 10 %	2.193 cd	0.092 d	2.013 bc	2.150 g	0.089 e	1.983 abc
G.E. 15 %	2.247 bc	0.096 c	1.867 d	2.450 ab	0.117 a	2.017 abc
M.E. 5 %	2.210 bcd	0.074 h	1.833 de	2.533 a	0.097 c	2.167 a
M.E. 10 %	2.257 b	0.097 c	2.017 bc	2.353 bcd	0.109 b	2.127 ab
M.E. 15 %	2.210 bcd	0.122 a	2.143 a	2.383 bc	0.108 b	2.050 abc
L.E.5 g L^{-1}	2.227 bcd	0.089 e	1.733 e	2.333 cde	0.091 de	2.067 abc
L.E.10gL^{-1}	2.340 a	0.109 b	1.883 d	2.260 def	0.107 b	1.947 bc
L.E.15gL^{-1}	2.197 cd	0.085 f	2.070 ab	2.253 defg	0.098 c	1.917 c
L.S.D 5 %	0.058	0.001	0.117	0.107	0.003	0.185

Means within columns followed by different letters are significantly different (p< 0.05), G.E., garlic extract; M.E., moringa extract; L.E., licorice extract; N, nitrogen; P, phosphorus; K, potassium.

Discussion

Results showed that plants treated with garlic extract were the best in the increase of branches number, leaves and branches fresh and dry weights, and plant content of total chlorophyll in both seasons. Where, plants treated with 15 % garlic extract was the best in the increase of the branches number in the first year in both seasons, leaves and branches fresh and dry weight after 5 and 17 months during both seasons and plant content of phosphors after 17 months during both seasons. In addition, this treatment was ranked second in plant content of alkaloids percentage after 5 and 17 months at both seasons. On the other hand, plants treated with 5 % garlic extract was the best in plants content from total chlorophyll after 5 and 17 months during both seasons, and total sugars content after 17 months at both seasons. This could be due to that garlic contains many sulfur compounds, vitamin B, vitamin C, enzymes, minerals such as (P, K, Zn, Mn, Mg, Ca, Na, and Fe), saponins, flavonoids, alkaloids, carbohydrates, and free sugars such as glucose, sucrose, and fructose (Abd El-Hamied and El-Amary, 2015). Thence, it displays a nutrition stable source for plants. Garlic derived organosulfur compounds especially the allicin, diallyl trisulfide, and diallyl disulfides (Jones *et al.*, 2007), which are powerful antioxidants (Leelarungrayub *et al.*, 2006) and can actively interact to the lipid bilayers (Gruhlke *et al.*, 2015). Previous studies reported that allelochemicals exert stimulatory or inhibitory effects vary accordingly at different concentrations of extract (Cheng *et al.*, 2016).

Moreover, results showed that plants treated with moringa leaf extracts were the best in the increase of branches number, plant minerals content, and alkaloids percentage. Where plants treated with 5 % moringa leaf extract was the best in branches number, plant minerals content (nitrogen and potassium) after 17 months at both seasons and plant alkaloids percentage after 5 months at both seasons. On the other hand, plants treated with 15 % moringa extract were the best in plant potassium and phosphorus content after 5 months at both seasons and plant alkaloids percentage after 17 months at both seasons. This might be due to that moringa leaf extract contains vitamins, β carotene, proteins, amino acids, zeatin which plays an important role in cell division, phenolic compounds, sugars, flavonoid pigments, and minerals such as (P, K, Ca, Mg, Fe, and Na). So, moringa leaf extract has the potential to enhance plant growth (Anwar *et al.*, 2007). These results are agreement with (Azra, 2011). On the other hand, plants treated with 10 g L^{-1} licorice extract was the best in increasing the total sugars content and nitrogen percentage after 5 months at both seasons. This could be due to that licorice extracts including important substance such as phenolic compounds, triterpenoid saponins, mevalonic acid which is the precursor in the synthesis of GA_3 acid in plants, protein, an amino acid (asparagine), lignin, polysaccharide, folic acid, vitamins, and pantothenic acid which play an important role in enhancing the growth of the plants (Arystanova *et al.*, 2001). Generally, these results agree with (Abd El–Hamied and El-Amary, 2015).

CONCLUSION

It could be concluded that for obtaining the best vegetative growth and alkaloids percentage in *Zanthoxylum beecheyanum* plants garlic extract at 15 % can be applied. Thus, the application of bio-stimulants could be considered as a good production strategy for a lower impact on the environment.

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تأثير مستخلص الثوم والمورينجا والعرقسوس علي النمو الخضري والمحتوي الكيميائي لنبات الكزاليزم

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أجري هذا البحث علي نبات الكزاليزم بأحد المشاتل التجارية (أبناء شعيشع) المنصوره - محافظة الدقهلية - مصر وذلك خلال الموسمين الزراعيين (2018/2017) و(2019/2018). يهدف البحث الي دراسه صفات النمو الخضري والصفات الكيماويه لنباتات الكزاليزم كإستجابة للمعاملة ببعض المستخلصات النباتية (الثوم وأوراق المورينجا بتركيز 5-10-15% والعرقسوس بتركيز 5-10-15جم/لتر) عن طريق الأضافة الارضية لكل مستخلص بمعدل 250 مل/ نبات كل خمسة عشر يوماً بداية من أول مايو حتي نهاية سبتمبر بالإضافة لمعاملة المقارنة (الماء). هذا ويمكن تلخيص النتائج المتحصل عليها كالاتي: تأثرت صفات النموالخضري والصفات الكيماوية لنباتات الكزاليزم بإستخدام المستخلصات النباتية. حيث سجلت معاملة مستخلص نبات الثوم بتركيز 15% زيادة معنوية وأعطت أعلى القيم بالنسبة الي عدد الافرع والوزن الطازج والجاف للافرع ولأوراق ونسبة القلويدات الكلية بالنبات ومحتوي النبات من الفوسفور، بينما زاد محتوي النبات من الكلوروفيل والكاروتينويد والسكريات الكلية عند المعاملة بمستخلص الثوم بتركيز 5%، بينما زاد محتوي النبات من النتروجين والبوتاسيوم عند المعاملة بمستخلص أوراق المورينجا 5 % في موسمي الزراعة علي التوالي مقارنة مع المعاملات الأخرى. وبالتالي نوصي بمعاملة نباتات الكزاليزم بمستخلص الثوم بتركيز 15% حيث تبدو أكثر ملائمة لإعطاء أفضل نمو خضري والمحتوي من القلويدات الكلية يليه المعاملة بمستخلص الثوم 5% تحت ظروف التجربةِ.